

possibly prolonged irritation without inflammation. It has the same segmental characteristics as the more acute pain and is sometimes difficult to differentiate from it (*i.e.* from the referred pain of visceral disease). It seems that there is an inability on the part of these injured neurons to adapt themselves to unusual requirements of physiological adjustment, whether originating in the external or in the internal environment. The change in sensibility is manifest under many conditions, such as changes in the weather, seasonal changes, tiring, such depressive emotions as worry, discontent, and unhappiness, and during menstruation. This type of pain is inadequately appreciated. It causes both physicians and patients much needless anxiety and results in operation when no serious danger exists''.

CONCLUSIONS AND SUMMARY

1. A common type of chest pain is described and is termed "neuralgic".
2. Neuralgic pain is the commonest chest pain.
3. It is associated with emotional instability, old or recent organic disease of heart and lungs,

debilitated and rheumatic states, and possibly with disease of the vertebral column.

4. The same pain may occur in the *apparent* absence of all these conditions, and any of these conditions may be present without this type of chest pain.

5. The pain in "chronic pleuritis", "effort syndrome", and some cases of organic disease of heart and lung cannot be differentiated in character from these neuralgic pains.

6. These pains are commonly mis-diagnosed as "pleurisy" or "heart disease", and when the same type of pain occurs in the abdomen, as "appendicitis" or "kidney trouble".

7. The prognosis varies greatly, being worst in chronic psychoneurotics. The pain is, on rare occasions, a moderately severe disability in itself.

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ABSCESS OF THE LUNG*

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REPORTS of strikingly improved results in the treatment of any condition, particularly if those reports emanate from several observers and from different clinics, always suggest that we should review our own material to discover whether we are doing the best that can be done for our patients. Because of the very excellent results that have been reported more recently^{4, 5, 6} it was felt that a survey of the histories of a series of cases of abscess of the lung should be undertaken. A few cases that were obviously of a fulminating type and hopeless from the beginning, multiple small abscesses complicating general blood infections, and small abscesses discovered only at autopsy were excluded from the series. The 106 cases studied were admitted to the Toronto General Hospital over an eight-year period, 1933 to 1940. A comparison be-

tween our results, a representative series by King and Lord⁷ and more recent figures by Neuhof and Tourof and Betts is readily made by reference to Table I and at once suggests

TABLE I.
COMPARATIVE MORTALITY FIGURES

	<i>T.G.H.</i> 1940	<i>King and Lord</i> 1934	<i>Neuhof and Tourof</i> 1940	<i>Betts</i> 1941
No. of cases	106	210	100	24
Cured	54%	40%	96%	96%
Improved	9%	0	0	0
Unimproved	2%	0	0	0
Dead	34%	35%	4%	4%

that there must have been something wrong in the diagnosis or treatment, or diagnosis and treatment of the earlier cases.

ETIOLOGY

In Table II is given an analysis of our cases under the usual etiological factors. The aspiration group included for the most part those cases

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TABLE II.
ETIOLOGY OF LUNG ABSCESS (106 CASES)

Aspiration	30%
Pneumonia	35%
Idiopathic	22%
Embolism (septic 5 cases, sterile 6 cases).....	10%
Trauma	1%
Perforation of adjacent lesion (œsophagus 1, subphrenic 1)	2%
Those that complicated carcinoma or adenoma of the bronchus were excluded.	

which followed tonsillectomy, extraction of teeth, other operations on the upper respiratory tract, general anæsthetics administered for general surgical procedures, and a few in which there was a fairly frank history of aspiration of material such as vomitus. After reading the histories one was often at a loss to know whether a particular case should be placed in the pneumonia, the aspiration or the idiopathic group. The reasons for the diagnosis of pneumonia were often obscure and the modes of onset differed in no way from those that had followed a definite aspiration. Indeed, it seemed reasonably certain that the actual etiological factor in nearly all the cases under these three headings had been aspiration of septic material. This opinion has been expressed recently by Betts.⁴ How easily material may be aspirated unknowingly into the bronchial tree was shown by Faulkner and Faulkner.⁸ In actual fact one need only recall the quantities of purulent material that the patient suffering from an acute suppurative sinusitis coughs out of his bronchial tree on first awaking, to realize that the cause for wonder is not that a few individuals should develop pulmonary foci but that many more do not do so. That the first sputum examined nearly always contained several organisms suggested that the condition had been initiated by aspiration. The occurrence of lung abscess as a complication of an ordinary pneumonia due to a pure pneumococcus or streptococcus infection is probably rare. This is possibly not true of staphylococcus, although the abscesses from which a pure culture of staphylococcus was obtained in this series were associated with a frank septicæmia or pyæmia.

It would seem that the probable course of events following the obstruction of a pulmonary vessel by a sterile embolus is extravasation of blood and fluid into the surrounding tissues, with œdema of adjacent bronchial walls and increase of intrabronchial secretion. Such debilitated tissue then forms an excellent culture

medium for infective organisms reaching it by way of the air passages, or by the much less frequent source, the blood stream.

A few abscesses of the lung seem to have followed definitely an injury to the chest, usually a severe blow or a severe crush. One can conceive of several ways in which an injury might predispose to infection of lung tissue. In the first place, as a result of a diffuse extravasation of blood into the lung tissue, a condition similar to that which follows the lodging of a sterile embolus might exist; again, infection of a frank collection of blood in the lung tissue such as that reported by Fallon⁹ might occur, and, as a third possibility, pain as a result of the injury, particularly if ribs have been fractured, might interfere with coughing and the clearing of secretions, thus predisposing to pulmonary infection.

Abscesses that result from perforation of adjacent septic foci into the lung are uncommon. Those that come from the mediastinum are almost invariably fatal and not amenable to treatment; those that occur as a result of perforation of a subphrenic abscess into an adherent lower lobe of the lung recover spontaneously as a rule if the subphrenic space is drained adequately. Abscesses secondary to carcinoma or adenoma of the bronchus must be kept in mind but will be considered only incidentally in this paper.

PATHOLOGY

It seems likely that the essential points in the pathology of this condition have been stated by Betts.⁴ He has called attention to the close

TABLE III.
LOCATION OF ABSCESSES
(Based upon 89 cases in which the location seemed reasonably certain)

Right upper	34%	65%
Right lower	29%	
Right middle	2%	
Left upper	14%	35%
Left lower	21%	

relationship that exists between the bronchus and blood vessels of a pulmonary lobule. A bit of septic material lodging in such a bronchus results first in atelectasis of the small segment of lung supplied, and, later, when the organisms gain a foothold, in thrombosis of the vessels. Such a series of events would explain the frequent finding of masses of necrotic material

in these abscesses. This means that all lung abscesses must be near some point on the surface of the lung and face chest wall, mediastinum, interlobar fissure or diaphragm. The segmental distribution of the bronchi has been described by Nelson^{2, 3} and Glass.¹ Space does not permit of a detailed description of them, but a knowledge of these special bronchopulmonary segments is essential to a proper understanding of the pathology, anatomical localization and treatment of abscess of the lung. In a recent careful analysis of 100 cases Glass found that in only 3 did the abscess lie in the segment having only a diaphragmatic and mediastinal surface.¹ All others were accessible for drainage. Since the shell of lung overlying the abscess is so thin, rarely more than one-half to three-quarters of an inch, the overlying pleura becomes involved early in all cases, pleural pain is a common symptom and the formation of adhesions between the overlying visceral and parietal pleura is an early occurrence. Because the abscesses occur in the periphery of the lung the bronchi with which they establish communication are invariably small, rarely exceeding 2 to 3 mm. in diameter.

Central lung abscesses are very uncommon and probably occur only as a result of the breaking down of a new growth or from local ulceration about a large foreign body. The apparent necessity of traversing a thick layer of seemingly normal lung tissue in draining an abscess indicates that localization has been faulty and that the abscess is nearer the surface at some other point. The thin layer of pulmonary tissue overlying the abscess bleeds little when incised, since many of its blood vessels are thrombosed.

If this interpretation of the pathology is correct it follows that the tendency is for most primary abscesses of the lung to be single. Only those due to a massive aspiration or to the occurrence of numerous septic emboli are likely to be multiple. Multiloculation is the result of an extension of the process about the margins of the original focus. Secondary abscesses may occur at any time as a result of aspiration of material from the abscess into bronchi of the same or other pulmonary segments. As the abscess becomes chronic there is increasing fibrosis and destruction of the surrounding lung tissue and the formation of a rigid wall which will not collapse following drainage. In certain abscesses partial or complete epithelization

from the bronchus occurs. Varying degrees of permanent dilatation in the neighbouring bronchi develop and the symptoms of bronchiectasis are added to those of chronic abscess. When these secondary changes occur spontaneous recovery is impossible and simple drainage will not effect a cure.

BACTERIOLOGY

The most striking thing about the bacteriology of lung abscess is the multiplicity of organisms found, and the fact that each abscess contains more than one type of bacteria. Abscesses that result from septic emboli containing a specific organism and cases of staphylococcus pneumonia that have gone on to abscess-formation constitute an exception to this general rule. In a series of cases in which bacterial examinations were made the following organisms occurred, with the frequency indicated. *S. viridans*, 29; *Staphylococcus*, 23; *M. pharyngis siccus*, 14; *S. hæmolyticus*, 12; pneumococcus, 11; fusiform bacilli and spirochaetes, 12; unidentified *M. catarrhalis*, 5; anaerobic streptococcus, 9; non-hæmolytic streptococcus, 6; diphtheroid bacillus, 5; *B. pyocyaneus*, 4; Friedländer's bacillus, 2; *B. coli*, 1.

DIAGNOSIS

History.—In the great majority of cases the onset is insidious. The patient often feels generally miserable with malaise and loss of energy; there is usually a mild fever and occasionally chills. Pain in the chest on breathing is not an infrequent symptom; cough is less common and, when present, is slight in degree. At the end of one to three weeks, but occasionally even later, the cough becomes productive and purulent sputum in gradually increasing amounts is raised. This material may be streaked with blood. Gross hæmoptysis is not uncommon and may indeed be the first symptom. If the lesion follows an operation on the upper respiratory tract there is often a fairly definite history of the development of chest pain and fever a few days after operation. At the end of one to two weeks the patient suddenly coughs up a quantity of sputum. Those cases that result from pulmonary infarction usually give a history of the sudden onset of chest pain, difficulty in breathing, and cyanosis. Instead of recovering fairly rapidly, as do most cases that do not die as a result of the size of the embolus and escape infection, there is a gradually increasing

fever and finally the production of purulent sputum. Some of these patients have bloody sputum immediately following the infarction.

Physical findings.—Perhaps the thing that should be emphasized most in regard to the physical findings is their paucity; indeed there may be no abnormal findings at all. As in many other diseases of the chest one is impressed by the few abnormal physical signs to be found in the presence of even very extensive pathological changes in the lung. On the other hand, a careful physical examination of the chest is always important and often helps greatly in the interpretation of the roentgenograms and localization of the lesion. A point of tenderness on the chest wall where the abscess is nearest to the surface, when present, is a valuable sign. The most constant finding is an area of localized dullness and râles.

X-ray.—Roentgenological examination of the chest is not only the most important method of diagnosis of the disease but the best way of following its progress. Films taken very early may present no abnormality or only a very small parenchymal shadow sometimes associated with a slight increase in the height of the diaphragm on the affected side. As the infiltrative changes in the lung increase the shadow cast becomes larger and more definite. It differs from that found in most ordinary pneumonias in being more localized as a result of the changes being confined to one or other of the broncho-pulmonary segments. A fluid level does not, of course, appear until some of the contents of the abscess have been evacuated into a bronchus and the entry of air permitted. This point requires emphasis. The absence of a fluid level does not mean that the patient has not got an abscess. When the lesion has become chronic a cavity may not be seen in the ordinary exposure because of the denseness of the infiltration that surrounds it. Such cavities may be demonstrated in Bucky diaphragm films or, still better, with the laminograph. Postero-anterior and lateral films are best for accurate localization of the lesion, but here again laminography often gives invaluable assistance. In more chronic cases x-rays following the introduction of lipiodol are important in determining the extent of the changes in the surrounding bronchi. Lipiodol can rarely be introduced into the abscess cavity.

Bronchoscopy is important in the exclusion of foreign bodies and new growths of the bronchi.

Bits of beef, chicken or fish bones may have been aspirated without the patient's knowledge. They rarely show in the x-ray. In addition, the bronchoscopic findings aid in localizing the disease. Whether the pus is coming from the upper, lower or middle lobe bronchus can always be determined. In addition to the escape of pus the degree of redness and œdema of the bronchial mucous membrane suggests the area most affected.

Examination of the sputum is necessary for the exclusion of specific infections, particularly tuberculosis and fungi. The very rare occurrence of a syphilitic lesion of the lung should be remembered.

Differential diagnosis.—A carefully taken history is of the greatest value. The primary lesion may be a carcinoma or adenoma of the bronchus. The majority of these may be seen through a bronchoscope, but those placed more distally may not be visible, in which case it must be considered that the lesion is an ordinary abscess. The subsequent progress of the case may demonstrate that this diagnosis was wrong.

An *empyema* from which a bronchial fistula has developed may be confused with abscess on history alone, but it is recognized readily by physical examination and x-ray. The presence of foul pus in the pleural cavity usually means that the original lesion was an abscess. This suggestion is confirmed by the history. The original abscess may or may not be recognizable in the x-ray at this stage.

Infected dermoids and *pulmonary cysts* may simulate simple abscesses. The presence of hair and detritus in the sputum in conjunction with a careful study of the x-ray pictures will generally result in recognition of the former. The presence in the x-ray of other translucent areas usually suggests the diagnosis in the case of *multiple cysts*. If the cyst be single its true nature may be recognized only at operation or when a portion of the wall has been obtained for microscopic examination.

TREATMENT

The early treatment is similar to that of pneumonia, including a trial of sulfonamide therapy. Drug therapy is unlikely to effect a cure, but the clinical condition of the patient may be improved because of the effect on the spreading infection in the surrounding lung tissue. If a connection with a bronchus has been established.

and sputum is being produced postural drainage should be instituted. Drainage should be repeated several times daily, depending on its effectiveness and the condition of the patient.

Bronchoscopy is of chief value in the diagnosis and localization of the lesion. It may in some cases improve the drainage, but at best, because of the pathology of the condition, can do little more. Repeated bronchoscopies should not be allowed to become a substitute for more effective treatment.

Pneumothorax, while occasionally accomplishing a brilliant cure, is a dangerous procedure and its use should be discontinued. The lesion is a superficial one, the abscess being covered by only a thin layer of poorly nourished lung. If an empyema is not produced immediately by a tearing of the superficial covering of the abscess it is likely to occur later, because the abscess has been deprived of the support of the chest wall. Empyema occurred twenty-five times in this series and in those in which it was possible only to drain the empyema the mortality was nearly 50%. Paralysis of the diaphragm more frequently interferes with than promotes escape of the contents of the abscess.

The only really effective treatment for those cases that do not recover promptly with medical measures is external drainage. Because much of the content of most abscesses is semi-solid necrotic and fibrinous material which cannot escape through small bronchi until liquefied, it is surprising that so many patients recover without surgical intervention. In this series of 106 cases only 20 recovered spontaneously, 5 showed improvement on leaving hospital and in most instances would probably recover incompletely, a recovery rate of less than 25%.

No hard and fast rule can be established as to the time that should be allowed to elapse before surgical drainage is undertaken. In general it may be said that all abscesses that are not showing unmistakable evidence of getting well should be drained at the end of 5 to 6 weeks. On the other hand, some should be drained much earlier if the clinical course is unfavourable. If the patient is becoming increasingly ill and the x-ray shows a diffuse shadow only, the establishment of a bronchial communication and production of a fluid level should not be awaited. Such a patient's best and perhaps only hope lies in effective drainage. No attempt can be made here to describe in detail the operation for drainage. The first

essential is an accurate localization of the lesion in relation to the chest wall. The operation is done most safely, and usually without too much difficulty, under local anaesthesia. Experience has shown that the lesser surgical procedures are most effective and that resection of a portion of one rib only is sufficient. Adhesions of the pleura having been demonstrated, a large needle is inserted into the cavity and the overlying thin segment of lung traversed either with a scalpel or cautery. The use of continuous suction to remove blood and the fluid content of the cavity and, if general anaesthesia has been necessary, the employment of some positive pressure, decrease the chance of aspiration. The interior of the cavity should be visualized if possible and all solid material removed. If the opening of a secondary locule into the main cavity is recognized it should be enlarged. The cavity is packed loosely with gauze with or without the addition of a tube. The wound in the chest wall should be packed open and under no circumstances closed about a drainage tube, since this may permit the forcing of air and infected material into areolar tissues and the occurrence of a virulent form of spreading cellulitis. Liberal smearing of the tissues of the chest wall with bipp before the abscess is opened into lessens the likelihood of this most serious complication. If open pleura is encountered, or it proves necessary to traverse a considerable thickness of lung tissue to enter the abscess, the approach has probably been incorrectly planned. The gauze packing is changed every second day or daily, depending on necessity, the indications usually being fever and the production of sputum. Drainage is continued until the cavity has disappeared and best until the fistula has closed.

Thoracoplasty is occasionally necessary to close large apical cavities that are not obliterated following drainage. It should be used rarely as a sole method of treatment, since it is unlikely to produce a complete cure.

Chronic cases in which the abscess has become multiloculated, secondary bronchiectasis has developed, extensive fibrosis of the surrounding lung tissue has occurred, or in which the abscess cavity has become partially or completely epithelized, cannot be cured by drainage alone. It is, in addition, in these cases that complications are frequent and mortality high. Such cases should be treated by lobectomy or in a few instances in which both upper and

lower lobes are involved, by pneumonectomy. Our experience would seem to show that these procedures are not only much more likely to effect a cure but that they are followed by a lower mortality. Excision of the upper lobe for such chronic lesions is a much more difficult and serious undertaking than excision of the lower lobe.

SUMMARY

1. The majority of pulmonary abscesses result from aspiration.

2. Septic and sterile emboli were the etiological factor in 10% of this series.

3. A knowledge of the anatomical distribution of the bronchi is helpful in understanding the pathology and probable location of lung abscesses.

4. The bacterial flora of the majority of lung abscesses is a mixed one, in which anaerobes are prominent, the only exceptions being those that arise from septic emboli and from pneumonia produced by a single organism.

5. Recovery of a large percentage of abscesses with medical treatment alone is not to be expected, because of the small calibre of the bronchi with which communication is established and the semi-solid content of many of them.

6. External drainage should be established in all cases not showing a definite tendency to get well at the end of five to six weeks and in some cases in which the clinical and x-ray course is unfavourable, even earlier.

7. The pathological changes that occur with chronicity make spontaneous recovery and cure by drainage alone unlikely. Such cases should be treated by lobectomy or, occasionally, by pneumonectomy.

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CHRONIC INFECTIVE ARTHRITIS CAUSED BY PSEUDOMONAS PYOCYANEA

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DURING these past few years medical literature has been enriched by contributions concerning the pathogenicity of *Pseudomonas pyocyanea*, or *B. pyocyaneus*.

Since the work of Gessard who first isolated this bacillus in 1882, and that of Jordan, who studied its varieties, the few observations published to date prove that this organism produces localized infections, in order of frequency, in the middle-ear, the skin, and the alimentary mucosa (Lartigan⁶). The respiratory tract, eyes, joints, kidneys, meninges,⁷ liver (Kruse and Pasquale⁶), are occasionally affected. This bacillus can also cause generalized infections, acute and fatal, particularly in infants. Wassermann reports an epidemic with eleven deaths of generalized infection starting in the umbilicus of the new-born. Krombals⁶ refers to seven cases of generalized infection by *B. pyocyaneus*

and reports an eighth from his personal experience.

We append a detailed description of a case which presents certain immunological interest.

CASE REPORT

In September, 1938, we examined a patient 77 years old, almost completely impotent, bed-ridden, emaciated, and aged, suffering for about ten years from chronic articular rheumatism, that had gradually become aggravated.

He complained of varying pains in his joints. There was a slight peri-articular oedema, an apparent muscular atrophy in the limbs, and a light deforming hypertrophy of the small articulations, mainly of the fingers. Passive movements induced contractions. Standing, he presented a simian appearance, his back was curved, the limbs semi-flexed, and his walk consisted in dragging his feet with lateral movements of the body. He could not dress unaided, nor even button his clothes.

His personal and family history was of no special interest. He was a farmer in the State of Vermont, and fixed the date of his first symptoms while working at an old sewage system.

Physical examination.—Sense organs apparently normal. Tonsils normal, coated tongue, foul breath, double denture. Occasional cough, but no sputum. The lungs showed a few sibilant râles. Blood pressure normal, pulse 90, heart and vessels normal. Blood count: 3,960,000 red blood cells, 10,600 white blood cells.

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